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EVALUATING RELEASES OF *CYPHOCLEONUS ACHATES* AND *AGAPETA ZOEGANA* AS POTENTIAL FIELD INSECTARIES AND EFFECTS OF WILDFIRE ON PREVIOUS RELEASES

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INTRODUCTION

Thirteen insects have been released as biological control agents of spotted knapweed, *Centaurea maculosa* Lamarck, in the United States. Of the 13, 2 of the root-feeders, *Agapeta zoegana* L. and *Cyphocleonus achates* Fahraeus, have become established at many sites in Montana and cause the most damage to knapweed plants. Small knapweed plants are often killed by feeding of young larvae, while many larger plants will not flower if infested with *A. zoegana* (Rees et al. 1996). Feeding by older larvae of *C. achates* will cause considerable damage to knapweed plants (Rees et al. 1995) and sometimes mortality. *A. zoegana* has been released in Montana since 1984 and *C. achates* since 1988. Rearing and dispersing these agents has been one of the primary programs at Montana State University, Corvallis Experimental Station. As a result of widespread wildfires of 2000 in Montana, a need for releasing a large number of biological control agents for spotted knapweed in or near burned areas is anticipated.

Forest Health Protection has evaluated several monitoring methods for *A. zoegana*: (1) root sampling for larvae, and (2) pheromone trapping, visual transects, and sweeping for adults. Two monitoring methods have been developed and tested for *C. achates*: (1) root sampling for larvae, and (2) sweeping for adults. Pheromone trapping for *A. zoegana* is very effective and does not require much time or expertise. Root-sampling and visual monitoring are also effective but require more expertise. Larval sampling for *C. achates* is the most effective. However, the method developed and tested in 1997-1998 requires approximately 2.5 hours at each site and expertise is needed to identify larvae in roots.

Many releases of *A. zoegana* and *C. achates* have been made on the Townsend Ranger District as part of their integrated weed management program. Several releases of *A. zoegana* and *C. achates* were within the burned perimeter of wildfires of 2000 on the Helena National Forest.

Objectives of the survey were to: (1) continue to monitor insect population trends and further evaluate several monitoring methods for both larvae and adults of *C. achates* and *A. zoegana* at 36 sites, (2) screen all sites for potential field insectaries for *C. achates*, and (3) at one site on the Townsend Ranger District, determine whether or not a previous release of *A. zoegana* survived the effects of wildfires of 2000.

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METHODS

Assessing Larval and Adult Populations

Larvae and adult populations of *A. zoegana* and *C. acha*tes were monitored at each site. Larvae for both insect species were monitored between June 6 and July 5, 2001. At each site we sampled 20 roots per site and recorded numbers of *A. zoegana* and *C. achates* larvae found. We compared these results to sampling 52 roots per site in 1997 or 1998. Adult *A. zoegana* were monitored with pheromone traps at the sites (Kegley & Sturdevant 2000). Five traps were placed at each site between July 5 and July 19. Traps were tacked to a 24-inch surveyor stake which were then driven into the ground so that the trap was flush with the height of most of the surrounding knapweed plants. Traps were arranged to best represent the spatial display of knapweed surrounding the release point and were at least 10 meters apart. Moths caught in traps were counted every 2 weeks following trap placement until the approximate end of moth flight, August 14.

Adult *C. achates* were sampled at each site where weevils had previously been released, and at additional sites where weevil larvae were found during the larval survey. This survey occurred between August 21 and 24. Sweep net sampling was done on each of 6 transects 50 meters in length. Adult *C. achates* were counted from net catches at the end of each transect. The same method was used to sample *C. achates* at most of the sites in either 1997 or 1998.

Assessing Sites for their Potential As Field Insectaries

Each site visited during 2001 was evaluated as a possible field insectary for *C. achates*. Criteria used for rating each site were: (1) at least 5 acres of knapweed plants large enough and vigorous enough to support root-feeding biological control agents, (2) established populations of *C. achates* as determined by larval and adult surveys, (3) good access, and (4) free from disturbances such as spraying and grazing.

Effects of Wildfire on a Previous Release of A. zoegana and C. achates

We also evaluated a site on the Townsend Ranger District, Helena NF that burned during the wildfires of 2000. Survival of *A. zoegana* and *C. achates* in roots following the fire and the site's potential as a field insectary were evaluated.

RESULTS

Assessing Larval and Adult Populations of A. zoegana

The sampling method that found the highest number of *A. zoegana* was larval but it also had the greatest inconsistency between 2 years of monitoring (1999 and 2001). Larval sampling is also the most time consuming, even when sampling only 20 roots per site. A high number of moths were also found using visual sampling and it was fairly consistent over 2 years of monitoring. Pheromone trapping was the most consistent across years but the least number of moths were found using this method. However, *A. zoegana* were found at all sights using all three sampling methods. Pheromone trapping and larval sampling (20 roots per site) are comparable in time (approximately 45 minutes) but pheromone trapping requires two visits to a site. However, pheromone trapping was most consistent across sites between the two sampling periods. Visual sampling takes the least amount of time (30 minutes) (Table 1).

Table 1. Comparing sampling methods for *A. zoegana* between 2001 and 1999.

Site	# Larvae 2001/1999	Visual- # Adults 2001/1999	Pheromones- # Adults 2001/1999
MT Tech	8/3	7/7	14/7
MRI	16/156	24/87	24/29
Flint Creek Camp	4/15	26/11	41/14
Dunkleberg	4/17	7/47	5/34
Belgium Gulch	6/7	14/4	29/1
Eastside Powerline	4/19	31/38	25/24
Barron Creek	9/64	27/34	11/3
Tobacco River	16/24	18/23	2/3
Reserve Street	7/104	22/69	61/35
Geldrich	10/72	6/13	2/1
Sloan Bridge	7/9	11/0	5/0
TOTALS	91/490	193/333	219/151

Assessing Larval and Adult Populations of C. achates

Populations of *C. achates* were found at most sites using both the adult visual and larval sampling methods in 2001. We found established populations of *C. achates* at 69% of sites sampling larvae and at 56% of sites sampling adults.

We found a higher percentage of roots infested sampling 20 roots/site (approximately 18%) in 2001 than the 52 roots/site sampled in 1997-98 (approximately 4%) (Table 2). This is probably related to non-randomly selecting the largest plants to sample and an increase in populations over time.

Table 2. Number of *C. achates* found using two sampling methods in 2001 and 1997/98.

Site	Location	# Larvae 2001/97-98	# Adults 2001/97-98
Cayuse Creek	Lolo NF	1/0	4/0
Valley Moon	Lolo NF	12/1	5/0
Cramer Creek	Missoula Co	2/1	8/9
Jocko River	Flathead IR	12/19	0/12
Geldrich	Flathead IR	4/0	0/0
Sloan Bridge	Flathead IR	2/0	0/*
Burnt Bridge	Kootenai NF	4/0	8/*
Belgium Gulch	Kootenai NF	3/6	32/0
Barron Creek	Kootenai NF	0/0	0/*
Tobacco River	Kootenai NF	0/0	0/0
MT Tech	Butte	10/0	43/0
MRI	Butte	0/0	7/0
Flint Ck Camp #3	B-D NF	3/0	1/0
Dunkleberg	B-D NF	0/1	2/0
Confederate Gulch	Helena NF	0/0	0/0
Slim Sam	Helena NF	4/2	0/0
TOTALS		57/30	102/21

**C. achates* was not released at these sites prior to the 1997-98 monitoring study and, therefore, were not included in the comparison of adult sampling between 1997-98 and 2001.

Potential Insectary Sites

Of the 36 sites sampled, only 10 were considered to meet most criteria for a field insectary (Table 3). An insectary may be developed at several of these sites if permission is granted by the agency managing the land, if minimal disturbances at the site are planned over the next few years, and if there is a partner in the area/forest interested in receiving additional agents. Additional sites will be evaluated in 2002 and 2003 for field insectaries for *C. achates* across Montana.

Table 3. Potential field insectaries in 2002

Site	Location	Potential Field Insectary *
Valley Moon	Lolo NF	+
Cramer Creek	Missoula Co.	+
Jocko River	Flathead IR	+
Geldrich	Flathead IR	0
Sloan Bridge	Flathead IR	0
Burnt Bridge	Kootenai NF	+
Belgium Gulch	Kootenai NF	+
MT Tech	Butte	+
Flint Ck Camp #3	B-D NF	+
Confederate Gulch	Helena NF	0

* (+) Meets all of the criteria for a field insectary; (0) meets most of the criteria for a field insectary.

Effects of Wildfire on a Previous Release of A. zoegana

We have preliminary data from a greenhouse study (Vander Meer pers.com.) and the field that suggests that larvae feeding in knapweed roots survive the direct of effects of fire. The Horse pasture site on the Helena NF burned with a high-intensity fire during the summer of 2000. However, we found *A. zoegana* in 9 of the 11 roots sampled. We also sampled some Canada thistle, *Cirsium arvense* in the burned area and found *Ceutorhynchus litur*a adults feeding on the leaves and stems.

We also did more intensive sampling at several sites on the Helena NF because of their proximity to burned areas. At the Confederate Gulch site, we recovered larvae in five out of six roots sampled. Many older, dead plants showed signs of previous mining from both root-feeding insects. At the Slim Sam site, we found 6 out of 10 roots infested with *A. zoegana*. We also found damage from *C. achates* in several roots.

DISCUSSION

All three methods evaluated for sampling *A. zoegana* are effective. Pheromone trapping requires the least amount of knowledge and skill and is not dependent upon climatic conditions. Visual sampling must be done during peak flight, fair weather conditions and in the afternoon for optimal results. There is a long sampling window for larval sampling between early spring and June 15 (the beginning of adult emergency). However, expertise is required to find and identify larvae feeding in roots.

For *C. achates* we recommend root dissection for larvae if the release was made within the previous 3 years. For established or older releases, we recommend either method. Finding adult weevils can be very difficult if the population is low. For larval sampling, we recommend selecting 20 of the largest roots in several directions with 30 m of the release point.

Approximately 100 additional sites will be evaluated in 2002 for field insectaries for *C. achates* across Montana. During the summer of 2002, we will also construct corrals for developing insectaries for *C. achates*. The field corrals will be developed according to Story's method (Story et al. 1996). However, there will be several differences. These include not mowing or irrigating plants, using plants grown naturally in the field, and collecting adult weevils from corrals only twice per week during the month of August. Weevils that are collected from the corrals will be redistributed on their respective forest or county lands. We will also compare numbers of weevils collected per unit time to numbers collected per unit time sweeping adjacent to or near corrals.

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